THE COPERNICUS EXPLAIN'D:

Or a BRIEF ACCOUNT of the

NATURE and USE

OF AN

Universal Astronomical Instrument,

FOR THE

Calculation and Exhibition of *New* and *Full Moons*, and of *Eclipses*, both *Solar* and *Lunar*; with the Places *Heliocentrical* and *Geocentrical* of all the *Planets*, *Primary* and *Secondary*, &c.

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To the Right Honourable

General STANHOPE,

One of His MAJESTY's

Principal Secretaries of State:

A great *PATRON* and *Encourager* of *Learning*, and of *Undertakings* for the *Publick Good*;

Particularly thoſe of the Author for the Improvement of

Aſtronomy and **Geography**

THIS SMALL

MANUAL

IS,

With all due Submiſſion,

and Gratitude,

Dedicated by

The Author.

THE *COPERNICUS* EXPLAIN'D.

THIS Aſtronomical Inſtrument (which is made agreeably to the *Copernican* Syſtem, and therefore by me named the *COPERNICUS*) conſiſts (beſides the immoveable Circle on the outſide, and the ſmall moveable central Circle within) of ten intermediate concentrical *Annuli*, or broad circular Rings, fitted to revolve one within another; but ſo, as to be capable of being fix'd,

by ſmall Pins, in any ſituation whatſoever. Six of the Circles toward the Center are ſo contriv'd, that they may be taken away, upon occaſion; and yet when they are put in, they are faſt connected to the Frame, as well as the other, and revolve as freely as they do. There is alſo a Terreſtrial Globe, of nine Inches Diameter, plac'd under the inner Circles, with its Hour Circle, turning along with it in its Diurnal Motion: And when thoſe Circles are remov'd, the Globe may be ſo elevated and fix'd at any height, and ſo regulated by Screws, as to be ready for the Exhibition of thoſe Eclipſes, which the ſix outward Circles aſſiſt us to diſcover; to which laſt does alſo belong a Rule, with a Groove, containing an Angle of 5° 37′ for the Moon's Path in Eclipſes. There is alſo a round Plate of Glaſs, with 12 Concentrical Circles therein, for the 12 Digits in Solar Eclipſes; whoſe Diameter bears the ſame proportion to the Diameter of the Globe, that the apparent Semidiameters of the Sun and Moon put together, do really bear to the Disk of the Earth in thoſe Eclipſes. There is, beſides, a Map of the Moon, with 6 Concentrical Circles, for the 12 Digits in Lunar Eclipſes;

whoſe Diameter bears the ſame proportion to that of the Globe, which the real Diameter of the Moon bears to the real Diameter of the Earth. There is alſo a dark Circle, repreſenting that Section of the Earth's Conical Shadow, along which the Moon paſſes in its own Eclipſes; and is ſo much leſs in proportion than the Diameter of the Globe, as is that of the real correſponding Circle to that of the Earth it ſelf. There are alſo two Threads, with their Plummets, fix'd to the Center of the Inſtrument; of frequent uſe in its Operations.

THE Nature of the ſeveral Parts of this Inſtrument is as follows:

THE outmoſt, or largeſt Circle, which is immovable, is the *Ecliptick*, with its known Signs, *Aries*, *Taurus*, *Gemini*, *&c.* This Circle is divided equally, from the beginning of *Aries*, or the *Vernal Equinox*, into 360 Degrees, or 12 Signs of 30 Degrees apiece; and is the Meaſure and Standard of the whole Inſtrument. Every Planet, or Point, or Line being ſtill fix'd, by knowing its Place along this Circle, either by the Signs, with the particular Degrees and Mi-

nutes, or by the bare number of Degrees and Minutes from the *Equinox.*

THE Second Circle is for the Months and Days of the Year; which Days being, in a manner, equal, this Circle is equally divided into 365 Parts; which is the number of Days in a *Julian* common Year. Nor will the *Leap Year* cauſe any great trouble, though it has one more Day in *February*; ſince it is already allow'd for in thoſe Aſtronomical Tables, whence all our Numbers have been transferr'd into this Inſtrument; and any Day therein, after *February*, is counted one farther than in the common Year. But here ſeveral things are to be noted; *viz.* (1.) That I ſuppoſe every Body can readily tell, in any Month of any Year, how remote every Day of it is from the beginning of that Year; and this both in common, and in Leap Years; and ſo can readily change one way of Computation for the other, as occaſion ſhall require: Thus we know by the old Memorial Verſes, that,

Thirty Days hath September,
April, June, and November:
February eight and twenty alone,
And all the reſt have thirty and one.

Accordingly, we can tell, that *April* 22*d*, the Day of the next total Eclipſe of the Sun, in this common Year, is the 112*th* day of the Year: As alſo, that *Sept.* 29*th*, or *Michaelmas* day, next Year, which is *Leap Year*, will be the 273*d* Day of that Year; and ſo in all other Caſes whatſoever. (2.) That in caſe we fix any one Day of the Circle rightly to that Place in the *Ecliptick* whereto it belongs, every other Day of the ſame Circle will thereby be rightly plac'd alſo. (3.) That I have therefore ſet down upon this Circle, the true Place of the *Vernal Equinox*, for the paſt Ages, as well as for the preſent: So that 'tis but bringing either the particular Year of our Lord it ſelf *ſince*, or any one which preceeded it *before Chriſt*, to the beginning of *Aries*, or the *Vernal Equinox*, and the whole Circle of Months is rightly plac'd, with reſpect to the *Ecliptick*, for that time. (4.) That yet if we deſire to be exact, we muſt, in this caſe, conſider further, what Year it is from *Leap Year* that we are concern'd with;

for if it be the firſt after it (which the firſt of each Century and Score *ſince*, and the fourth of each Century and Score *before Chriſt* always are) the Poſition of the Numbers is right of it ſelf, without any more conſideration: But if it be the ſecond after it, the Circle is to be turn'd one third of a Century's Motion, or one quarter of a Day ~~forward~~ backward; if it be the third, two thirds of a Century's Motion, or one half of a Day ~~forwards~~ backward, in order to its right Poſition; while if it be it ſelf Leap Year, the Circle muſt be turned one quarter of a Day ~~backward~~ forward, in order to ſuch a Poſition. (5.) Our Aſtronomical Centuries, Years, Months, and Days do ever commence from the Noon foregoing; ſo our 10*th* of *March*, in this Inſtrument begins at Noon *March* 9*th*, and ends at Noon *March* 10*th*; and is indeed reckon'd by 24 Hours intire, from the one Noon to the other. Thus, becauſe this is the third after *Leap Year*, I turn this ſecond Circle ~~onward~~ backward half a day, and find, that the *Vernal Equinox* happens this Year, *March* 9. *d.* 18 *h.* 0 *m.* or as we commonly reckon, on *March* 10. about Six of the Clock in the Morning; and that, by conſequence, *April* 21. *d.* 9 *h.* 42 *m.* the time of the middle of the next great Eclipſe of the Sun, corre-

ponds

ponds to the 13° of *Taurus*, in the outmoſt Circle of the *Ecliptick*.

THE Third Circle is the Annual Elliptick Orbit of the Earth, here rightly repreſented by a Circle; with the unequal Diviſions of the *Ellipſis*, correſponding to the inequality of the Earth's Motion. This Circle is fix'd to the due place of the Ecliptick by a ſmall Arch, of the place of the *Perihelion*; as the Days of the Month were fix'd to the *Equinox*.

THE Fourth Circle contains the Menſtrual Orbit of the Moon, with its Periodical Revolution about the Earth; both in 360 Parts, and in 27 Days, 7 Hours, and 43 Minutes. The actual Diviſions are here made for the mean State of the Orbit, which is variable; but Points are ſet at every five Degrees (to be thence ſupply'd at every Degree, and proportionably in other Caſes) according to its ſeveral Degrees of Eccentricity. Upon the inner large part of this Circle there is alſo a Spiral Line, with the progreſſive mean Motion of the Moon's *Apogee* for a Century; with every one of the Months, and almoſt Days Motion alſo; That ſo when

when we have fix'd, by a proper Table, the mean Place of the *Apogee*, for the beginning of any Century, we may thereby find its mean Place to any time in the ſame Century alſo, without any other Aſſiſtance whatſoever.

THE Fifth Circle contains, along its ſpiral, the mean Motion of the Moon's Nodes; and particularly, of the Aſcending Node whence the Numbers begin, for an intire Century, with its Months and Days; that ſo when we have, by a proper Table, once fix'd that Node right for the beginning of any Century, we may, as before, be hereby enabled to place it right at any time in the ſame Century, without any other aſſiſtance: Only we muſt here note, that the Motion of the Nodes being retrograde, the Numbers on this Circle are counted backward.

THE Sixth Circle contains, in a ſpiral, the mean Motion of the Moon for the ſeveral Days in the Year, number'd at length: And the Moon's mean Motion for the diſtinct Years of the Century are put at the utmoſt edge of the Circle, for our future Benefit in this Caſe alſo.

THUS

THUS far I have deſcrib'd the largeſt and principal Circles, intended for the Diſcovery of the New and Full Moons; and eſpecially for the Calculation of Eclipſes, both Solar and Lunar.

AS to thoſe ſix leſſer Circles that follow to the Center, they need little Explication, being all of a piece; and are indeed nothing but broad *Annuli*, or Rings, to contain the Orbits of ſuch of the Primary Planets as could be put upon them; with the Orbits of all the Secondary Planets, both thoſe about *Saturn*, and thoſe about *Jupiter*, in their due Proportions; that ſo, when the Sun is ſuppos'd in the Center, the Orbits of the Primary Planets may alone be made uſe of; when *Saturn* is there His; and when *Jupiter* is there His *Satellites* may alone be contemplated. Only we muſt here note ſeveral things, for the better underſtanding of this Part of our Inſtrument. (1.) Becauſe *Saturn* and *Jupiter*'s Orbits were too large for theſe inner Circles, they are repreſented by ſmall Spheres, on the ſecond and ſixth larger Circles before deſcrib'd; becauſe *Saturn*'s Motion is only about 12 Degrees in a Year, or one in a Month; as alſo *Jupiter*'s only

only about 30 Degrees in a Year, or 2 ½ in a Month; there is no great neceſſity for theſe diſtinct Orbits, with their Motions, to be engrav'd upon theſe Circles; eſpecially becauſe of the Confuſion it would introduce there. (2.) Theſe Orbits are here Circular, or accommodated to the Planets mean Diſtances from the Sun; but ſo, that the preſent Places of the *Aphelia* and *Perihelia* are noted on the utmoſt edge of the whole Inſtrument, and the quantity of their ſeveral conſtant Eccentricities are alſo noted where their Orbits begin; that ſo the little Sphere repreſenting each Planet, may be ever plac'd nearer to or farther from the Center, as its real Diſtance ſhall require; only the Eccentricities of the *Earth*'s and *Venus*'s Orbits are too ſmall to be here ſenſible. (3.) Theſe Orbits are all repreſented in the Plain of the Ecliptick, as it was here neceſſary to do: But then the preſent Places of the Aſcending and Deſcending Nodes being ſet down at the utmoſt Edge, each Planet's Inclination to the Ecliptick, and Latitude on the Earth, may be nearly diſcover'd for this Age at the ſame time; I mean this, in caſe we obſerve the quantity of the ſeveral Angles of Inclination, which thoſe Orbits make

make with the Ecliptick, which are as follows:

	°	′
Saturn	02	30
Jupiter	01	20
Mars	01	52
Venus	03	24
Mercury	06	54

(4.) The ſeeming Motions of theſe *Aphelia* and Nodes in the Ecliptick, is only a Degree in 72 Years: 'Tis therefore but allowing to theſe *Aphelia* and Nodes that Motion of one Degree in 72 Years forwards, and their Places in the Ecliptick are known for all Ages. (5.) When *Saturn*'s Secondary Planets are concern'd, the Sun is to be ſuppos'd in its proper Place of the Ecliptick, at the diſtance of 166 Feet from the Center of the Inſtrument: In which Caſe theſe Orbits are in true Proportions, with regard thereto. And when *Jupiter*'s are concern'd, it is to be ſuppos'd, in the like place, at 160 Feet diſtance, for the ſame purpoſes. At which Points, if a Lamp be plac'd, and this Inſtrument be mov'd in a kind of Circular Orbit about it, we ſhall have a juſt and natural Repreſentation of the Revolution of

of theſe Primary Planets, with their Satellites, about the Sun, both in their Annual and Menſtrual Motions.

I COME now to ſhew the particular Uſes of this Inſtrument: And ſhall do it in the Solution of the following PROBLEMS.

PROB. I.

LEMMA.

To Rectifie the firſt moveable Circle, or that of the Months and Days, to any Moment of Time, paſt, preſent, or to come.

TURN this Circle till the given Year, exactly correſponds to the *beginning of Aries*, in the outmoſt Circle; but ſo, that for the ſecond Year after *Leap Year* you turn it farther one third; for the third Year two thirds of a Century's Motion ~~forwards~~ backward; and for the *Leap Year* one third ~~backwards~~ forward, beyond that beginning of *Aries*. for w' there are points. Thus,

Thus, if you would Rectifie this Circle to the time of the great Solar Eclipſe this Year, which is the third after Biſſextile, you muſt put a Point that is a little beyond 1701, *two thirds of a Century's Motion backwarder than the beginning of* Aries; *by which means this Circle will be entirely Rectify'd to the time.*

PROB. II.

LEMMA.

To Rectifie the ſecond moveable Circle, or that of the Earth's Annual Orbit, *with its true* Anomaly *on it, to any time paſt, preſent, or to come.*

THIS is readily done, by bringing its beginning to the time aſſign'd in the Arch; and is ſo eaſie and obvious, as to need no farther Explication. Only it muſt be noted, that this Place of the *Perihelion*, with regard to the Earth, is the Place of the *Aphe-*

lion, with regard to the Sun; or the Place where when the Sun is, the Earth is moſt remote from it, whence every *Anomaly* is to be begun.

Thus if you add to 3 ſ. 7 d. 40 m. *the Place of the* Perihelion, *at the Commencement of this Century, or* 1701, *thoſe* 12 m. *which is its Motion in* 14 *Years; you will have* 3 ſ. 7 d. 52 m. *for the Place of the* Perihelion *at that time. To which if you bring the beginning of this Circle, you will have this whole Circle, with the Earth's true* Anomaly, *or Place thereon, exactly rectify'd to the time of that Eclipſe.*

PROB.

PROB. III.

LEMMA.

To Rectifie the third moveable Circle, which is that of the Moon's Apogee, *with its true* Anomaly, *or Place upon it, to any time, paſt, preſent, or to come.*

LOOK in the proper Table for the place of the Moon's *Apogee*, at the beginning of the Century aſſign'd, and accordingly fix it: Count along the Spiral that is upon it the Years, Months, and part of a Month of that Century, and lay one of your Threads over that Place; then remove the *Apogee* to that Thread; this will exactly ſhew its mean Place. After this, obſerve how far the Sun is from the *Apogee* or *Perigee*, and whether it have lately gone paſt, or is going towards one of 'em, and turn the Circle accordingly forward or backward one

third of that Diſtance. For in the former Caſe that quantity is to be ſubſtracted from, in the other added to the former Place, in order to have the true Place. I mean this only as we reckon 45 *d.* for the Limit: And remember, that the ſame Equation is to be ſubſtracted, or added, for any Number that is equally diſtant from that Limit; as for 40 and 50, 60 and 30, 70 and 20, 80 and 10, and ſo in all other Caſes whatſoever. Only obſerve, that if neareſt the Limit you take conſiderably leſs, and remoteſt from it a very little more than one third, you will ſtill more exactly Rectifie this Circle.

Thus if you look for A. D. 1701. *you will find the mean Place of the* Apogee *then to be* 11ˢ 8° 18′ *and if you turn the Circle forward to* Apr. 22. *you will have the mean Place of the* Apogee *then. And if by turning ſtill forwards, you add the third part of the Sun's Diſtance, or* 7° *to the former Place, you will have the true Place of the* Apogee *at that time,* viz. 6 ſ. 27 d. 23 m.

PRO-

PROB. IV.

LEMMA.

To Rectifie the fourth moveable Circle; which is that of the Moon's Nodes, *for any time, paſt, preſent, or to come.*

LOOK in the proper Table for the Place of the *Aſcending Node*, at the beginning of the aſſign'd Century, and there fix it. Count along the Spiral thereon backwards, the Years, Months, and part of a Month of that Century, and lay your Thread over that Place: Then bring the beginning of the Spiral, or Aſcending Node, to the Thread; which will give you the mean Place of that Node. Then turn the Circle forward a 20th part of the Sun's diſtance from either Node, if it have lately paſs'd it; or a 20th part backward, if it have not yet paſs'd it: This will fix the Nodes to their true

Places at that time. I mean this alſo as we reckon here 45° the Limit; and remember, that the Equation is to be ſubſtracted or added for any Number that is equally diſtant from that Limit: Only Obſerve, that if neareſt that Limit you take conſiderably leſs, and remoteſt from it ſomewhat more than $\frac{1}{20}$, you will ſtill more exactly Rectifie this Circle.

Thus, If you look for A. D. 1701. *you will find the mean Place of the Aſcending Node to be* 4ſ 27° 24'. *Then turn the Circle backward to* Apr. 22d, *and you will have the mean Place of that Node there. And if by turning ſtill backward, you ſubſtract a* 20th *part of the Sun's diſtance, or* 27', *you will have the true Place of the Node at that time,* viz. 7 ſ. 21 d. 9 m.

PROB.

PROB. V.

LEMMA.

To Rectifie the fifth moveable Circle; which is that of the mean Motion of the Moon *it ſelf, for every Day of a* Julian *Year, for any time, paſt, preſent, or to come.*

LOOK in the proper Table for the *Mean Place of the Moon*, at the beginning of the Century aſſign'd, and there fix the Circle. Then look along the outward Edge of this Circle for the compleat number of Years of that Century, and laying your Thread exactly over that Year, remove the Circle ſo far. Then count along the Spiral upon it, the number of Days and Parts till the time aſſign'd; over which laying your Thread, ~~remove the Circle ſo far.~~ This rectifies the Circle of the Moon's Mean Motion for that time. *Thus*

Thus if you look for A. D. 1701. *you will find the Mean Place of the Moon to be* 10 ſ. 15d. 20 m. *whither bring the beginning of the Circle accordingly. Lay then a Thread over the Number* 14, *and bring the former Place thereto: Then is this Circle intirely rectify'd at that time.*

Note, That the Moon's Motion in Hours is not diſtinguiſh'd here on the Spiral; becauſe it may be better eſtimated on the Ecliptick it ſelf.

Note farther, That when you go upwards, as in the Years before the Chriſtian Æra, contrary to what is uſual, you add the Mean Motions of the Node, and ſubſtract thoſe of the Apogee and Moon it ſelf to and from the Epocha, to prepare the Numbers for the Inſtrument. But then, if you thereupon chuſe proper Numbers for the beginning of each Century before, as well as after the beginning of the Chriſtian Æra, you will have no farther Difficulties in the uſe of the Inſtrument it ſelf. Thus, if for the beginning of the 431ſt *Year before* Chriſt, *you take* 500 *Years backwards for the Epocha of the Century; and* 69 *compleat Years after it for the beginning of the Year it ſelf, you will have no farther difficulty in the uſe of this Inſtrument in that caſe.*

Note alſo, That the three laſt of theſe Circles will as well ſerve for a Century backwards as forwards, from any Root, or Epocha. I mean, if the known number

of

of Degrees for any number of Years backwards in the Century, be taken on the ſide of the Epocha contrary to that it belong'd to, if the Years had been forwards; as every one will eaſily find upon the leaſt Conſideration and Trial.

Note farther, That to make this Inſtrument as ready as poſſible for the preſent Century, the Epochæ of the Places of the Moon's Apogee and Aſcending Node, and of the Moon it ſelf, at the beginning of it are noted by the following Marks upon the outmoſt Circle, ☉ ☊ ☽, *with Points at the oppoſite Places at the ſame time: And the like Marks may be made for any other Century, as occaſion ſhall require.*

Note laſtly, That our Time is here always the Mean or Equal Time; which the more curious may correct by the known Equation-Table: But ſince this laſt is little more than a quarter of an Hour different from the other at the utmoſt, and almoſt always much leſs, it is rather too nice to deſerve much Conſideration in ſuch an Inſtrument.

PROB.

PROB. VI.

To find the Sun's *True Place in the Ecliptick, for any time, paſt, preſent, or to come.*

REctifie the two outmoſt moveable Circles. Look what Sign, Degree, and part of a Degree correſponds to the Time aſſign'd. Lay your two Threads over the firſt of *Aries*, and over that Place; and count the *ſame Number* along the Earth's Orbit, which you find belongs to that Number on the Ecliptick. This correſponds to the True Place of the Sun in the Ecliptick for that time.

Thus, if you look for 21 h. 42 m. *upon the Ecliptick on* Apr. 22*d. you will find over againſt it about* 43 d. 30 m. *This reckon'd along the Earth's Orbit, reaches from* 260 d. 10 m. *which is over againſt the Equinox, to* 302 d. 35 m. *over againſt which laſt Number ſtands* 12 d. 15 m. *of* Taurus; *which is therefore the Sun's True Place in the Ecliptick at that time.*

PROB.

PROB. VII.

To find the Moon's *True Place in the Ecliptick, for any time, paſt, preſent, or to come.*

RE&tifie the third and fifth moveable Circles. Lay one of your Threads over the Moon's Mean Place, and the other over the Moon's Apogee. Count along the Moon's Orbit the *ſame Number* which is intercepted between the Threads on the Ecliptick. A Thread laid over that Place, correſponds with the Moon's True Place in the Ecliptick.

Thus, if you look for 111 d. 21 h. 42 m. *on the fifth moveable Circle, you will find it is diſtant from the Moon's Apogee, along the Ecliptick, about* 192 d. 40 m. *which Number, taken in the Moon's own Orbit, on the third moveable Circle, correſponds to* 12 d. 15 m. *of* Taurus, *the True Place of the Moon at that time. But it is here to be noted, that when the Moon's Apogee is either in Conjun&tion or Oppoſition with the Sun, the Eccentricity of the Moon's Orbit is the*

the greateſt; and the Points or Marks neareſt the Apogee are the true ones: (which is nearly the Caſe in this Example, and accordingly made uſe of in it) and when it is in the Octants, that Excentricity is in a Mean, and the Lines and Numbers themſelves are right; but when it is in the Quadratures, the Points or Marks neareſt the Perigee are the true Places: And ſo in all other intermediate Poſitions whatſoever. Which Circumſtances being conſider'd, and proportionably allow'd for in all Caſes, this Problem will be exactly ſolv'd.

PROB. VIII.

To find the True Conjunctions *and* Oppoſitions *of the Sun and Moon, with the* New *and* Full Moons, *for any time, paſt, preſent, or to come.*

REctifie the firſt, ſecond, third and fifth moveable Circles, as before directed. After that find the True Places of the Sun and Moon for the time given, as before. If they are either the ſame, or directly oppoſite, you have the time already; if not, carry your Threads

Threads that lie over the two Places reſpectively, along their own Orbits, forwards or backwards; ſo that you carry the Moon's 13 Degrees and a quarter to the Sun's one; or a Day's Motion of one, to a Days Motion of the other; and ſo all along proportionably, *i. e.* ſomewhat above half a Degree to an Hour, till the Moon's Place overtakes the Sun's. For that Place where they are coincident, gives you the Conjunction or Oppoſition, with the New or Full Moon.

Thus, If you look for the Sun's Place at Noon, Apr. 21. *which is, Aſtronomically,* 21 *compleat Days in that Month, you will find it about* 11 d. 20 m. *in* Taurus. *And if, in like manner, you look for the True Place of the Moon at the ſame time, you will find it about* 28 d. 40 m. *in* Aries: *Whence if you carry both the Threads ſo far as correſponds to* 21 h. 42 m. *you will perceive that the Moon does there overtake the Sun; which ſhews, that at that very time, or* Apr. 22 d. *about a quarter before Ten in the Morning, the Sun and Moon will be in Conjunction, and it will be New Moon. But Obſerve, that if you do not at all know before-hand, at what time of any Month the Conjunction or Oppoſition will fall, you muſt find the diſtinct Places of the Sun and Moon at the beginning of the Month, and ſo go*

downwards, as to the Days, as well as Hours, and parts of an Hour, till they are coincident; as has been juſt now directed; and you will thereby find the Day, Hour and part of an Hour of the next Conjunction or Oppoſition. You may alſo if you pleaſe, find the True Places of the Sun and Moon, to that laſt time, over again, as before directed; eſpecially where there is a deſign to examin an Eclipſe at the ſame time; for the greater Accuracy. But Note, that if you only intend to find the time of Conjunction or Oppoſition, in order to an Eclipſe, you need not examin any Month or Days, but only ſuch as are near one of the Nodes, or within the Limits of ſuch Eclipſes; which Limits will be ſtated under the next Problem.

PROB.

PROB. IX.

To find whether there will be either a Solar, *or a* Lunar Eclipſe, *at any* Conjunction *or* Oppoſition, *for any time paſt, preſent, or to come.*

ALL the Circles firſt rectify'd, and the Time and Place of the True Conjunction or Oppoſition found, as already directed, Lay one of your Threads over that Place, and the other over the neareſt Node. If that Diſtance be leſs than 16 Degrees and an half, and it be a Conjunction, there will be an Eclipſe of the Sun ſomewhere: If it be greater, there will be no Eclipſe. If that Diſtance be leſs than 10 *d.* 38 *m.* and it be an Oppoſition, there will be an Eclipſe of the Moon: If it be more, there will be no Eclipſe.

Thus, it happening this Year 1715. *that the Sun and Moon are in Conjunction about a quarter before Ten o' Clock, on the next* 22d *of* April, *and that at* 8 d. *diſtance from the Deſcending Node; it is evident there will at that time happen an Eclipſe of the Sun. And there happening an Oppoſition* October 31ſt, *about a quarter paſt* 4 *in the Morning, within* 7 *Degrees and an half of the ſame Node, 'tis evident there will then be an Eclipſe of the Moon alſo.*

Note here, that ſeveral other Circumſtances of Eclipſes, may be diſcover'd by the Solution of this Problem. Thus, becauſe the Conjunction for the next Solar Eclipſe happens before *the Moon has reach'd its Deſcending Node, 'tis plain, it muſt belong to the Northern Parts more than to the Southern. Becauſe it is in a ſort of a Mean Diſtance between that deſcending Node and the Limit, it will be a great and Total Eclipſe, and the greateſt in the Northern Temperate Zone. Becauſe it happens near the* Aphelion *of the Earth, and near the* Perigee *of the Moon, when the apparent Diameters of the Sun is ſmaller, and of the Moon greater than uſual, it will not be Annular, but Total, and that for ſome few Minutes alſo; I mean along that Line, which the Center of the* Penumbra *deſcribes upon the Earth. And becauſe the Solar Eclipſe this Year happens here in the Day-time, and the Lunar in the Night, they will both be viſible; I mean, in caſe*

caſe the Clouds cauſe no interruption. So that theſe Circumſtances do not need Particular Problems for their Solution.

PROB. X.

To Rectifie the Globe, and its Hour Circle, for the Exhibition *of Eclipſes.*

BRing *London* to the graduated ſide of the Meridian, and turn the Hour Circle till 12 o' Clock is pointed to by its Index: Then turn the Globe, with its Hour Circle, ſo far forward or backward, as the right Aſcenſion belonging to the Diſtance of the Place of the Conjunction, from the beginning of *Cancer* or *Capricorn*, does require; reckoning ſtill 15 Degrees to an Hour, and 1 Degree to 4 Minutes. Hold the Globe in that Poſition, and bring 12 in the Hour Circle, to the graduated edge of the Meridian again, and there fix it faſt, to move with the Globe all along afterward. By this means the Index will tell you the true time, as it is counted

ted at the Meridian of *London*, during the whole time of the Eclipſe. And Note, that the Diſtance from *Cancer* or *Capricorn* it ſelf, if increas'd or diminiſhed one 13*th* part, or one Degree in 13, according as the Poſition of the Sun and Moon ſhall require, will nearly give the Right Aſcenſion; reckoning the Limit 45, as under the 3*d* and 4*th* Problems, and increaſing or diminiſhing the Equation as there alſo. But Note, that this Diſtance it ſelf will never err 2 *d.* 30 *m.* or 10 Minutes in time, from the Truth; nay, will uſually be much nearer the ſame, even without any Allowance for that Correction at all.

Thus if you bring London *to the graduated edge of the Meridian and the Hour of* 12 *to the Index; and remove the Globe, with its Hour Circle, backward from Eaſt to Weſt* 50 *Degrees,* i. e. 3 *Hours* 20 *Minutes; and then turn the Hour of* 12 *to the Index again, and there fix it, you will have the Globe, with its Hour Circle, rectify'd for the time of the next Total Eclipſe of the Sun, and every part of it will agree to that Hour which the Index ſhews on the Hour Circle.*

PROB.

PROB. XI.

In any Solar *Eclipſe, conſider'd in general, and with regard to the whole enlightened Diſk of the Earth, to find when and where it will begin and end; whether it will be any where total, or every where only partial; and, if partial, how many Digits will any where be Eclipſed; with the other general Circumſtances of the ſame.*

TAKE the eleventh part of the Diſtance of the Place of the Conjunction from the neareſt Node, for the Latitude of the Moon at the middle of the Eclipſe. Remove the inner Circles; and elevate the Globe that ſtands beneath them, North or South, as the Caſe ſhall require. By the ſide Screws place

place it in the Center or Axis of your Circles. Lay your Rule, with its Glaſs of 12 Circles (then ſet over its middle Point) and its Lamp or Candle, ſo that the Node may lie in a Poſition ſuitable to that of the Moon's Orbit at that time (which is eaſily known from the Obſervations under the laſt Problem); and ſo, that the middle Point, or that under the Center of the Glaſs, may be directed to the Place of the Conjunction in the Ecliptick. Turn your Globe, rectify'd as before, till the Index points to the time of the True Conjunction, already found; That is very nearly the time of the middle of the general Eclipſe. Then turn your Globe, and draw your Glaſs backwards any number of Minutes equally; ſo that an Hour in the Hour Circle may ever correſpond to an Hour in the Path of the Moon; and till the Shadow of the edge of the Circular Glaſs begins to touch the neareſt Place of the Globe; for that is the Time, and that the Place, when and where the general Eclipſe begins. Carry both Motions forward, and obſerve, whether the Central bright Spot does any where touch the Globe; if it does not, the Eclipſe is no where Total, and the Circles caſt on the Globe will ſhew the

the number of Digits eclips'd: If it does touch, note the Time and Place when and where it does ſo; for that is the Time, and that the Place of the entry of the Central Shadow, or total Darkneſs upon the Earth. Do the like as to the Central Spot, or other edge of the Circles going off the Globe afterwards; this will, in like manner, ſhew the Time and Place of the end of Total Darkneſs, and of the whole Eclipſe reſpectively And by this means all the other Circumſtances of the general Eclipſe of the Sun, may be moſt eaſily and readily diſcover'd and exhibited to the Eye, with the greateſt Pleaſure and Satisfaction.

Thus, in the next great Solar Eclipſe, conſider'd in general, you will find that it will begin in 17 d. *of North Latitude, and about* 90 d. *weſtward from* London; *and this about* 21 m. *after* 7, *and will end in the Latitude of* 40, *about* 98 d. *to the Eaſt of* London; *and this at* 3 m. *after* 12. *That it will be a Total Eclipſe for about* 150 *Miles in breadth, and that the Center of the* Penumbra *will go near the* Lizard *Point*, Briſtol, Stamford *and* Boſton; *and ſo by* Stockholm *and* Archangel, *into* Ruſſia, Siberia, *and* Eaſt Tartary.

Note, that if inſtead of a Lamp, or Candle, you make uſe of the Sun it ſelf; either by placing the Inſtrument ſo, that the Rays

of

may themſelves fall parallel to the Axis of the Glaſs, or that they may be inclin'd to it by a reflecting Speculum, *or Looking-glaſs, it will be better.*

Note alſo, that if with a Pencil, put thro' the Axis of the Glaſs, you draw a Line; or with a ſharp Pin or Needle therein, make Points upon the Globe, as you move it and the Glaſs together, you will have the Path-way of the Center transferr'd upon the Globe; and may thereby exactly find all the Places where the Eclipſe will be Total, or Annular, or Central; and may eaſily ſee, from the like Lines drawn, or Marks made at any number of Digits diſtance, how broad the Path of any kind of partial Eclipſe will be alſo over the whole Earth; which how entertaining and uſeful a Sight it may be to all the Curious, I leave to their own Trial and Determination.

Note alſo, That the Problem, thus ſolv'd, includes one main part of that famous Diſcovery of Sir Chriſtopher Wren's, *Dr.* Halley's, *and Mr.* Flamſteed's, *publiſh'd by the laſt, and nam'd,* The Conſtruction of Solar Eclipſes, *without the tedious Method of Calculation. Only what they are forc'd to do with no ſmall pains, and in no ſhort time geometrically, is here done with great eaſe and quickneſs and an exact imitation of the Originals in Nature, and ſo with a great deal more Pleaſure and Satisfaction.*

PROB.

PROB. XII.

In a Solar Eclipſe, *conſider'd in particular, and with regard to any ſingle Place, to find when it did, or will begin and end; whether it was or will be there Total or Partial; and if Partial, how many Digits were or will be Eclipſed: With the other particular Circumſtances of the ſame in that Place.*

THIS Problem is, in effect, already ſolv'd, under the former Problem: It being as eaſie to obſerve when the Shadow of the edge of the Glaſs-Circle firſt touches, or laſt leaves any Place upon the Globe; which is the beginning and ending of the Eclipſe there: when the bright erect Line croſſes it, which is its middle there: How near

near any Circle of Digits comes to it then: Which is the number of Digits Eclipſed there: With other the like Circumſtances of that Place, as it was before to obſerve the ſame for the Eclipſe in general. Nor is there any occaſion for farther Directions.

Thus the next great Solar Eclipſe will begin here at London, April 21. *about* 8 h. 7 m. *in the Morning; its middle will be about* 9 h. 13 m. *its end about* 10 h. 24 m. *and it will be intirely, or very nearly Total: tho' if it be Total here, it cannot be ſo for much more than a ſingle Minute of Time; as Dr.* Halley's *particular Map, fitted for this Eclipſe, will eaſily ſhow.*

Note, that if in the Solution of this, and the foregoing Problem, you add for Eaſt, and ſubſtract for Weſt Longitude, reſolved into Time, you will have the Moment of each of theſe Appearances at any other Place alſo.

Note alſo, that the Problem, thus ſolv'd, includes the remaining part of the foremention'd famous Diſcovery of the Conſtruction of Solar Eclipſes; *and that not only as done with the like greater eaſe, quickneſs and pleaſure, but principally that with the ſame operation, and without any new trouble, it diſcovers every thing for* all particular Places *at once; which neither that Method of*

Con-

Conſtruction, nor any other Method of Aſtronomy *whatſoever could pretend to before. And yet all this is here done only by ſuch a cloſe imitation of Nature, as is in it ſelf moſt eaſie and obvious, and what one would now imagin ſhould have come into the Thoughts of* Aſtronomers *firſt of all, before any other Contrivance whatſoever.*

PROB. XIII.

In a Lunar *Eclipſe, to find whether it was or will be Total or Partial; and if Partial, how many Digits were or will be Eclipſed; which of the Lunar Spots and Mountains were or will be obſcured; and when they did or will begin or end to be ſo: How long the Entire, or Central, or Partial Eclipſe will laſt. With all the other Circumſtances of the ſame.*

TAKE away the Globe, and ſet the Dark Circle in its Place. Take alſo the Glaſs of 12 Circles away, and put the Map of the Moon, with its 6 Circles, in its Place. Then do in all things with this Map of the Moon, as you were order'd to do with the Glaſs-Circle

Circle before. By this means you will have all thoſe *Phænomena* of Lunar Eclipſes ſolv'd, with greater eaſe, and the like pleaſure, which were before repreſented in the Solar. Nor is there any new difficulty in the Application. Only Note, that this Map of the Moon being too ſmall to have the Names of its ſeveral Seas and Lands engraven on it, it will be convenient to have withal a larger Map of the Moon, with thoſe Names, as an Explication of the other; which accordingly is here provided, and plac'd on one ſide of the dark Circle, which is us'd with it. And Note farther, that thoſe who have a mind to be here very particular and exact, may uſe the larger Map of the Moon inſtead of the other, in caſe they join with it a dark Circle of 16 Inches and a quarter in Diameter: For the ſame Proportion which the Diameter of our ſmaller Moon of two Inches and an half, bears to that of our dark Circle of ſix Inches and two fifths, does the Diameter of that Circle, or of the larger Moon bear to that of a Circle of ſixteen Inches and two fifths Diameter. Whence its plain, the larger Moon, and that largeſt Circle, will more exactly exhibit

ſuch Lunar Eclipſes than the other: Tho' I believe there will be but few, who will not be ſatisfy'd with the ſmaller dark Circle; ſo I have not provided the larger: Which yet Mr. *Senex*, or Mr. *Hudſon*, the exact Engraver and Framer of this Inſtrument, will readily procure for any that deſire them But then the ſeveral Circles concern'd muſt be ever ſo adjuſted, that the perpendicular of their Centers may ſtill be the ſame with the Latitude of the Moon at the middle of the Eclipſe; and that as meaſur'd by a Scale, which is ſo much larger than ours, as their Diameters are larger.

Thus we ſhall find by this Inſtrument, that there will be an Eclipſe of the Moon this Year, Octob. 31. *that it will not be a Total, but a Partial Eclipſe; that the Digits eclips'd will be* 8, *and this on the North ſide of the Moon's Body: That the Eclipſe will begin about* 2 h. 58 m. *and end about* 4 h. 40 m. *in the Morning; and that Mount* Ætna *will enter the Shadow about* 3 h. 8 m. *and emerge about* 5 h. 17 m.

Note,

Note thoſe that would exactly imitate Nature in theſe Lunar Eclipſes, muſt let the Globe ſtand, and have a Lamp or Circle of Light, larger in Diameter than the Globe, through whoſe Shadow the Map of the Moon muſt paſs. They ought alſo to have different Maps of the Moon out of Hevelius, *to fit the different Librations of the Moon, or the ſmall variety there is in that Face which is expos'd to us in different Eclipſes. But ſince this Method would be much more troubleſome, and but little more advantageous or entertaining, I choſe the former eaſie way of exhibiting theſe Lunar Eclipſes by this Inſtrument, leaving the other to thoſe among the Curious, who ſhall think fit to beſtow any extraordinary coſt and trouble about it.*

But Note, That the Diameters of the Penumbra, *and of the Moon, are here ſtill fitted to their Mean Quantity, when the Earth and Moon are about the ſhorter Axis of their Ellipſes: So that when they are near their Aphelion and Apogee, their Perihelion and Perigee; or the Earth its Aphelion, and the Moon its Perigee; the Earth its Perihelion, and the Moon its Apogee; ſome ſmall Differences will ariſe in the Buſineſs of Eclipſes; which yet may eaſily be allow'd for on a little conſideration. Thus the next viſible Eclipſe of the Sun happening ſomewhat near the Earth's Aphelion, and nearer the Moon's Perigee, as the Poſition of their Orbits at that time in this Inſtrument will ſhew; the Moon will appear a little larger, and the Sun*

a little ſmaller than ordinary; whereby the Sun will be about 3 Minutes and 3 quarters under a total Eclipſe, all along the Central Path of the Moon's Shadow, and the 12 *Digits on your Glaſs will not include the whole. In this Caſe you are to ſuppoſe all the Circles 2 thirds of a Digit inlarg'd, and the Central Digit ſo much broader. Thus the next inviſible Eclipſe of the Sun,* Octob. 16. *happening ſomewhat near the Earth's Perihelion, and nearer the Moon's Apogee; the Moon will appear ſomewhat leſs, and the Sun ſomewhat greater than ordinary; ſo that this Eclipſe will be only Annular, and not Total, and the Digits Eclipſed will not be quite* 12. *In this caſe you are to ſuppoſe all the Circles diminiſh'd 2 thirds of a Digit, and the Central Digit ſo much narrower; and the like Allowances are to be made in the Numbers upon the Path of and perpendicular to the Moon's Shadow, in the Diameter of the Moon's Map, in the Duration of Eclipſes,* &c. *which muſt be left to every curious Perſon's own eſtimation; only with this intimation, that theſe Differences from the Standards here given are ever ſo ſmall, and commonly ſo inſenſible, that they may be well look'd on as almoſt perfectly inconſiderable in the uſe of this or the like Inſtruments.*

Yet the Latitude of the Moon will ſometimes well deſerve an allowance; and may be corrected by taking not much above a 12*th part of the diſtance from the Node, near the Moon's Perigee, and almoſt a* 10*th near its Apogee, inſtead of that* 11*th part, which is the uſual ſtandard:*

dard: whence at this next Eclipſe the real Latitude of 44 m. 10 ſ. *will be here repreſented by* 41 m. 40 ſ. *on our Scale; and ſo proportionably in all Caſes whatſoever.*

SCHOLIUM.

Since the Computation and Exhibition of all Eclipſes, paſt or future, is by this Inſtrument become now ſo very eaſie, it will be fit to examin thereby all the old Eclipſes men ioned by Hiſtorians, and to compare them with Original Accounts, for the ſettling all Ancient Chronology and Hiſtory; which Deſign was the very Occaſion of the Contrivance of the ſame. In particular, it will be fit to examin hereby the very old pretended Eclipſes, mention'd in the Chineſe *Records; and to ſee how far they will agree with the Real Eclipſes of thoſe remote Ages. Which may be alſo one valuable uſe, as to Lunar Eclipſes at leaſt, of the acute Dr.* Halley's *Tables for the Periodical Returns of Eclipſes; which he has given us a Specimen of already, and which we ſhortly expect the Completion of from him.*

PRO-

PROB. XIV.

To find the Heliocentrick *True Places of all the Primary Planets, for any time, paſt, preſent, or to come.*

BY the help of the proper Tables, which are publiſh'd in my Aſtronomy, find the true Place of each Planet, as is there directed: From thence you may ſet them accordingly by this Inſtrument.

Thus for Example, Let us compute the Heliocentrick Place of Mercury *to the Time of the next great Solar Eclipſe.* See Aſtron. Lect. Edit. Lat. p. 302, 303. 304. Eng. p. 337, 340.

1701.

	ſ.	°	′
1701	8	04	02
Years 14	1	14	06
Apr.	0	08	19
Days 21	2	25	56
h. 21	0	03	35
m. 42	0	00	07
Anom. Med.	0	26	05
Long. Hel.	8	01	15
Add. Preceſ. Æquinoct.	0	29	08
True Place of Merc.	9	00	23

But becauſe this Method is not wholly free from the trouble of Calculation, you may frequently help your ſelf by ſome good Ephemeris *; ſuch as is annually ſet out by Mr.* Parker ; *whence you may readily transfer the Heliocentrick Places of the Planets into your Inſtrument. Accordingly, by either Method, at the Time of the next Solar Eclipſe the ſix Primary Planets Heliocentrick Places will appear to be theſe :*

	ſ.	°	′
Saturn	05	22	42
Jupiter	01	03	38
Mars	07	06	41
Earth	07	12	15
Venus	09	11	09
Mercury	09	00	23

PROB.

PROB. XV.

To find the Geocentrick *Places of any of the Primary Planets, for any time, paſt, preſent, or to come.*

HAving found, as before, the *Heliocentrick* Places of the other Planets, and particularly that of the *Earth*, noted all by ſeveral ſmall Spheres, and having allow'd for their proper Eccentricities in the ſticking of thoſe Spheres, Lay one of your Threads from the *Earth* to the Planet, and the other Thread laid parallel thereto from the Center, gives you the *Geocentrick* Place of that Planet for the time aſſigned.

Thus,

Thus, at the forementioned Time, the five Primary Planets Geocentrick *Places will be nearly these:*

	ſ.	°	′
Saturn	05	17	44
Jupiter	01	05	07
Mars	06	26	42
Venus	11	27	51
Mercury	00	16	21

PROB.

PROB. XVI.

To find the Mutual Aſpects *of all the Primary Planets with one another, and with the* Sun *and* Moon; *their* Conjunctions, Oppoſitions, Trines, Quartiles *and* Sextiles, *both* Heliocentrick *and* Geocentrick, *for any time, paſt, preſent, or to come.*

THIS is eaſily done when the Places themſelves of the Primary Planets, with that of the Moon, are once found by the former Solution. Nor is there then any difficulty in noting the ſeveral Angles of diſtance 120°, 90° and 60°, which make the *Trine*, *Quartile* and *Sextile Aſpect*. But this Problem looks too like the Fooleries of *Aſtrology*, to deſerve any nicer Explication.

PROB. XVII.

To find whether any Primary Planet, with its Satellits, be Direct, Stationary or Retrograde, at any time paſt, preſent, or to come.

HAving found the *Heliocentrick* and *Geocentrick* Places of the Planets, and ſet ſmall Spheres to repreſent 'em: From the Sphere repreſenting any Planet lay two Rules or Threads, ſo as to touch the Earth's Orbit on both ſides. If the Earth be conſiderably *without* that mixtilinear Triangle, the Planet is Direct; if conſiderably *within* it, it is Retrograde; if *about the Limit*, it is Stationary: or at leaſt lately was, or ſoon will be ſo. Nor can you by this means abſolutely determin, near thoſe Limits, whether the Planet be Direct, Stationary, or Retrograde. But then, by finding its Geocentrick Place two ſeveraltimes within a few Days of one another, and obſerving whether the Planet

at the latter time be farther, or in the ſame Place, or not ſo far in the Ecliptick as it was at the former time, you may entirely determin the Problem. Nor is the Caſe of the Inferior Planets much different from that of the Superior ones, as to this matter. Only Note, that the Rules or Threads muſt be laid from the Earth to touch their Orbits; which is the *Station*, or Limit of the *Direction* and *Retrogradation* of thoſe Planets, and is call'd their *utmoſt Elongation*; and that the Inferior Planets Poſition near thoſe Limits, are here correſpondent to the Earth's Poſition in the Superior. Nor is this a Caſe of ſuch difficulty, as to require any nicer Conſideration.

Thus, at the time of the forementiond Eclipſe, we ſhall find by this Method, that Saturn *and* Mars *will be Retrograde; and that* Jupiter, Venus *and* Mercury *will be direct.*

PROB.

PROB. XVIII.

To find the Places of the Circum-Saturnals *and* Circum-Jovials *from their Oppoſition to the Sun, at any time, (ſince their Motions have been known) paſt, preſent, or to come.*

FIND the Place of *Saturn* or *Jupiter* in the Ecliptick, for the given time, as before. Then, by the proper Tables of their Satellits Motions about them, when they ſhall be made; (for we have only one Set of ſuch Tables yet publiſh'd, and render'd fit for our purpoſe; I mean thoſe of *Caſſini* for *Jupiter*'s innermoſt) fix the beginning of their Orbits, or the ſmall Spheres ſtuck there to repreſent thoſe Satellits: Place alſo, or imagin a Lamp, or Candle, at the diſtance of about 160 Feet for *Saturn*, and about the ſame number of Feet for *Jupiter*. By this means you will have a true and noble Repreſentation of theſe Syſtems of Secondary Planets at any time whatſoever.

PROB. XIX.

To find the Eclipſes of theſe Secondary Planets, for any time (ſince their Motions have been known) paſt, preſent, or to come.

THE time of Oppoſition is the time of the Middle of any Eclipſe; and by taking away and adding the half duration of that Eclipſe, you have the time of the Immerſion and Emerſion. 'Tis plain therefore, that finding the Oppoſition, does, in effect, find the Immerſions, Emerſions, and intire Durations of thoſe Eclipſes alſo.

Note, that the time of half Duration in Jupiter's *innermoſt, which is the moſt remarkable Satellit in this matter, is nearly* 1 h. 6 m. *and ſo the whole Duration about* 2 h. 12. m. *perpetually.*

Note,

Note farther, that only one of theſe Appearances, the Immerſion or Emerſion of a Satellit, is generally viſible at the ſame time; viz. *the Immerſion from the Conjunction of the Primary Planet with the Sun till its Oppoſition; and the Emerſion from its Oppoſition till its Conjunction.*

Note alſo, that till we have more exact and ſuitable Tables of the reſt of theſe Secondary Planets, it will be proper, two Nights ſucceſſively, to obſerve the Poſition of as many as we can of them; and from thoſe Obſervations to fix their Places, with relation to their Primary ones, to thoſe times. For ſince their Orbits, on our Inſtrument, gives their ſeveral Periods exactly enough; from thoſe Periods their future Places and Poſitions may be found by two ſuch Obſervations, for a great while; and ſuch Poſitions may be with pleaſure enough compar'd with a great number of other Obſervations afterwards. Nor do we wholly want an Aſtronomical Method, as to the moſt uſeful of theſe Secondary Planets, which is the innermoſt about Jupiter; *ſince the Tables neceſſary for placing the ſame right, and for the Eclipſes for ſome Years to come, tho' too large for this ſmall Manual, are publiſh'd in my Aſtronomy, with full Directions for their uſe alſo; to which I muſt refer the curious Reader.*

Note,

Note farther, that we are generally to look for only one of Saturn's *Satellites; there being few Glaſſes that can ſhew us any more; and none but thoſe of the famous* Caſſini *that can diſcover the two innermoſt.*

Note here, that Jupiter's *Planets are all in or near the Plain of his Equator, which is near the Plain of the Ecliptick it ſelf; and that they are hardly at all Eccentrical. That* Saturn's *moſt viſible Planet, diſcover'd by* Hugenius. *is the fourth in order, or the outmoſt but one: as alſo that its Planets are in or near the Plain of its Ring, which is about* 31 *deg. inclin'd to the Ecliptick; and that they do not any of them appear to be very much Eccentrical neither.*

And note, that our Terreſtrial Globe may be ſo contriv'd, that it may be alſo us'd with an Horizon, as any other Terreſtrial Globe may; and by conſequence, thoſe who buy its Celeſtial Fellow, may at the ſame time have a Pair of Globes, *as well as a* Copernicus; *which will at once ſave almoſt all the Charges of one Globe; and afford a Foundation for the underſtanding of both the principal parts of* Aſtronomy *alſo, I mean* the Doctrine of the Sphere, *to which the Globes; and* the Theory of the Planets, *to which our* Copernicus *does immediately belong.*

Note

Note laſtly, That all who purchaſe this Copernicus, *and deſire to have it explain'd more diſtinctly to them, according to the Directions in this Paper, may apply themſelves to the Author; who will endeavour to make the ſeveral Parts and Uſes of it eaſie and familiar to them.*

Mar. 18. $17\frac{14}{15}$. Will. Whiſton

ERRATA.

PAGE 2. Line 21. *read* 5° 37′ p. 6. l. 10, 12. *r.* backwards; l. 15. *r.* forwards; p. 11. l. 19. 24. *r.* about 160.

APPENDIX.

IN this *Appendix* I have ſet down thoſe *Aſtronomical Tables*, which are chiefly neceſſary, in order to the ready Uſe of the preſent Inſtrument: And they are, 1. A Table of the *Mean Place* of the *Apogee*, and of the *Aſcending Node* of the *Moon's Orbit*, as well as of the *Moon* it ſelf, at the beginning of every Century for 1000 Years before, and ever ſince the Chriſtian *Æra*. 2. A Table of the middle of the general *Eclipſes* of the *Sun*, within ſome Hours under or over, for above half this Century. This is deriv'd from Dr. *Halley's* SAROS, or very uſeful Table of the firſt 18 Years of the ſame Century; and will ſave ſome trouble in the uſe of this Inſtrument, and indeed in any other method of Calculation for the ſame purpoſe; which muſt needs be ſhortened by knowing the Time ſo nearly as is here ſpecified. 3. A like Table of the middle of the *Eclipſes* of the *Moon*, for the ſame interval, and deriv'd from the ſame Original; as well as ſerving to the like purpoſe with the former. The reſt of the Aſtronomical Tables, any way neceſſary in this Inſtrument, may be found at the end of my *Aſtronomical Lectures*, which are now publiſhed both in *Latin* and *Engliſh*.

I. A

I. A Table of the Mean Place of the *Moon's Apogee* and *Node*, and of the *Moon* it ſelf, in the beginning of the ſeveral Centuries, before and ſince the Chriſtian *Æra*.

Before Chriſt	Apogee			Node			Moon		
	ſ.	o	'	ſ.	o	'	ſ.	o	'
1000	9	0	15	5	19	29	9	13	39
900	0	19	26	1	6	17	7	21	30
800	4	8	37	8	22	6	5	29	20
700	7	27	49	4	7	54	4	7	10
600	11	17	0	11	23	44	2	15	1
500	3	6	11	7	9	32	0	22	51
400	7	25	22	2	25	21	9	0	41
300	10	14	33	10	11	9	9	8	32
200	2	3	45	5	26	58	7	16	23
100	5	22	56	1	12	47	5	24	13
A.D 1	9	12	7	8	28	36	4	2	3
101	1	1	18	4	14	25	2	9	53
201	4	20	29	0	0	14	0	17	43
301	8	9	40	7	16	3	10	25	34
401	11	28	52	3	1	51	9	3	24
501	3	18	3	10	17	40	7	11	15
601	7	7	14	6	3	29	5	19	5
701	10	26	25	1	19	18	3	26	56
801	2	15	37	9	5	6	2	4	46
901	6	4	48	4	20	55	0	12	37
1001	9	23	59	0	6	44	10	20	27
1101	1	13	10	7	22	33	8	27	17
1201	5	2	21	3	8	21	7	6	7
1301	8	21	32	10	24	10	5	13	58
1401	0	10	44	6	10	59	3	22	49
1501	3	29	56	1	25	47	1	29	39
1601	7	19	7	9	11	36	0	7	29
1701	11	8	18	4	27	24	10	15	20

II. A Table of the general *Eclipſes* o the *Sun*, within leſs than a Day under or over, till *Ann. Dom.* 1754

A. D.	Days current at Noon.
1701	*Jan.* 27
	Jul. 24
1702	*Jan.* 17
	Jul. 13
1703	*Jan.* 6
	Jul. 3
	Nov. 27
	Dec. 27
1704	*May* 2
	Nov. 16
1705	*May* 11
	Nov. 5
1706	*Apr.* 30
	Oct. 25
1707	*Mar.* 22
	Apr. 21
	Sept. 14
	Oct. 14
1708	*Mar.* 11
	Sept. 3
1709	*Feb.* 28
	Aug. 24
1710	*Feb.* 17
	Aug. 13
1711	*Jan.* 7
	Feb. 6
	Jul. 4
	Dec. 28
1712	*Jun.* 22
	Dec. 17
1713	*Jun.* 11
	Dec. 6
1714	*May* 2
	June 1
	Oct. 27
	Nov. 26
1715	*Apr.* 22
	Oct. 16
1716	*Apr.* 11
	Oct. 4
1717	*Mar.* 31
	Sept. 23
1718	*Feb.* 19
	Mar. 20
	Aug 14
	Sept. 13
1719	*Feb.* 8
	Aug. 4
1720	*Jan.* 28
	Jul. 24
1721	*Jan.* 16
	Jul. 13
1722	*Jan.* 6
	Jun. 2
	Nov. 27
1723	*May* 22
	Nov. 16
1724	*May* 11
	Nov. 4
1725	*Apr.* 2
	May 1
	Sept. 25
	Oct. 24

1726	Mar. 22
	Sept. 14
1727	Mar. 11
	Sept. 4
1728	Feb. 28
	Aug. 24
1729	Jan. 18
	Feb. 16
	Jul. 15
1730	Jan. 7
	Jul. 4
	Dec. 28
1731	Jun. 23
	Dec. 17
1732	May 13
	Jun. 11
	Nov. 6
	Dec. 6
1733	May 2
	Oct. 26
1734	Apr. 22
	Oct. 15
1735	Apr. 11
	Oct. 5
1736	Feb. 29
	Mar 31
	Aug. 25
1737	Feb. 19
	Aug. 15
1738	Feb. 8
	Aug. 3
1739	Jan. 27
	Jul. 23
	Dec. 18
1740	Jan. 16
	Jun .4
	Dec. 8
1741	Jun. 3
	Nov. 28
1742	May 21
	Nov. 15
1743	Apr. 12
	May 11
	Oct. 5
	Nov. 4
1744	Apr. 2
	Sept. 25
1745	Mar. 23
	Sept. 15
1746	Mar. 10
	Sept. 3
1747	Jan. 28
	Feb. 27
	Jul. 25
1748	Jan. 17
	Jul. 15
1749	Jan. 8
	Jul. 4
	Dec. 29
1750	May 23
	Jun. 21
	Nov. 16
	Dec. 16
1751	May 12
	Nov. 5
1752	May 3
	Oct. 26
1753	Apr. 23
	Oct. 16
1754	Mar. 10
	Apr. 10
	Sept. 4
	Oct. 3

III. A Table of the *Eclipses* of the *Moon*, within less than a Day under or over, till *A. D.* 1754.

A.D.	Days current at Noon.
1701	*Feb.* 11
	Aug. 7
1702	*Dec.* 23
1703	*Jun.* 18
	Dec. 2
1704	*Jun.* 6
	Nov. 30
1706	*Apr.* 17
	Oct. 10
1707	*Apr.* 6
	Sept. 30
1708	*Mar.* 25
	Sept. 18
1710	*Feb.* 2
	Jul. 29
1711	*Jan.* 23
	Jul. 18
1712	*Jan.* 12
	Jul. 7
1713	*May* 28
	Nov. 21
1714	*May* 18
	Nov. 10
1715	*May* 7
	Oct. 31
1717	*Mar.* 16
	Sept. 9
1718	*Mar.* 5
	Aug. 29
1719	*Feb.* 23
	Aug. 18
1721	*Jan.* 2
	Jun. 28
	Dec. 22
1722	*Jun.* 18
	Dec. 11
1 24	*Apr.* 27
	Oct. 21
1725	*Apr.* 16
	Oct. 10
1726	*Apr.* 5
	Sept. 30
1728	*Feb.* 14
	Aug. 8
1729	*Feb.* 2
	Jul. 29
1730	*Jan.* 23
	Jul. 18
1731	*Jun.* 9
	Dec. 2
1732	*May* 28
	Nov. 20
1733	*May* 17
	Nov. 10
1735	*Mar.* 27
	Sept. 21
1736	*Mar.* 15
	Sept. 9
1737	*Mar.* 6
	Aug. 30
1739	*Jan.* 12
	Jul. 8
1740	*Jan.* 1
	Jun. 29
	Dec. 22
1742	*May* 7
	Oct. 31
1743	*Apr.* 26
	Oct. 20
1744	*Apr.* 16
	Oct. 11
1746	*Feb.* 25
	Aug. 18
1747	*Feb.* 13
	Aug. 8
1748	*Feb.* 2
	Jul. 29
1749	*Jun.* 20
	Dec. 13
1750	*Jun.* 7
	Dec. 1
1751	*May* 28
	Nov. 20
1753	*Apr.* 7
	Oct. 2
1754	*Mar.* 26
	Sept. 19

F I N I S.